Research and Innovation Funding Instruments to Raise South Africa's Competitiveness in Science and Technology: Lessons from other Developing Countries.

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Summary and Recommendations

Universities South Africa initiated this investigation with the objective to identify and examine funding instruments used in other developing countries (mainly South Korea, Brazil and China) to achieve international competitiveness and encourage and incentivise research and innovation and to develop relevant recommendations.

The report provides evidence of the importance of research, development and innovation. It is argued that innovation is recognised internationally as the fundamental cornerstone of economic growth, employment, international competitiveness and development. Economic progress is driven by the invention and application of new technologies and R&D is one category of spending that develops and drives these new technologies.

It is also suggested that innovation can make a difference in addressing urgent developmental challenges such as providing access to drinking water, eradicating neglected diseases or reducing hunger. Examples of transformative technologies include the polio vaccine; the new seed varieties that launched the Asian Green Revolution; anti-retroviral drugs that rendered HIV/AIDS a chronic and manageable disease; the M-PESA mobile payment platform and others. OECD is quoted stating that there is evidence that agricultural R&D has greater impact on poverty reduction than most other public investments.

The literature review provides evidence that both theory and empirical studies justify government involvement in the promotion of R&D. Research and Development is beneficial to the creation of employment. A country that lags behind in innovation tends to lose jobs to those countries that lead in the introduction of new technology. It affects positively total factor productivity and social rates of return from R&D are substantially greater than the private rates of return.

The Review *of International Trends Related to Funding Incentives* indicates that funding instruments are developed to be 'fit for purpose'. They are targeting the appropriate populations; they have critical size; they have well defined and limited objectives etc. The approach 'one fits all' is avoided and hence, successful countries have a multitude of funding instruments.

The approaches used by governments to support innovation depend on their understanding of the innovation process. In the linear model of innovation (1st generation innovation model) governments support R&D through sponsored

research; tax incentives and direct subsidies, loans and repayable contributions to business, universities and others.

When the chain linked model (2nd generation innovation policy) prevails, emphasis is placed on the development of Strategic Research Partnerships (SRP). Such partnerships are defined as cooperative relationships involving organisations that conduct or sponsor R&D. Examples include research joint ventures; strategic alliances and networks; licensing and sponsored research agreements involving universities, government laboratories and firms; university based entrepreneurial start-ups etc.

Countries appear to monitor each other and successful instruments are adopted internationally. Clustering approaches and smart specialization are followed by most countries with a national system of innovation. Clusters bring together firms, higher education and research institutions and other entities to facilitate collaboration on complementary economic activities. Smart Specialization is a policy framework to help firms strengthen scientific, technological and industrial specialization patterns while identifying and encouraging the emergence of new domains of economic and technological activity.

In the recent years the increasingly competitive environment for ideas talent and funds forced governments to adjust their funding instruments and the research excellence initiatives arose. These are instruments designed to encourage outstanding research by providing large scale long term funding to designated research units. They support the recruitment of excellent researchers from abroad, the extension or improvement of the physical infrastructure and the training of researchers. A number of governments attempt to establish excellent research from scratch by establishing large research institutions.

China and Korea based their developmental plans on science, technology and innovation. Since 1978 the Deng Xiaoping theory of S&T has been the theoretical and ideological foundation of China's S&T Policy. The central theme is that S&T is a primary productive force and its management should promote economic development.

Since 1985 the Chinese S&T system was reformed as it was included in the broader agenda of economic reforms. R&D has become an important element of economic policy. Science and Technology industrial parks; university science parks; and technology business incubators were initiated. Similarly new infrastructures to encourage industry-science relationships and spin offs from public research organisations started to fill the gap.

In Korea the techno-industrial sphere was developed first through 'reverse engineering' led by government research institutes in 1960s-80s. It was followed by a phase of corporate R&D led by Chaebols in the 1980s-90s. It is suggested that probably the most striking aspect of South Korea's development is the radical shift of its economy from low- to high-tech value-added sectors in only a few decades.

A novel approach in Brazil is the extra-budgetary sectorial funds. Since 1999, a new research financial framework has evolved with the establishment of extra-budgetary

sectorial funds for research in universities with interest to companies. The funds are supported through levies and relevant taxes.

In all three countries science, technology and innovation are coordinated and supported by the political authorities. For example in China the *National Steering Group for S&T and Education* in the State Council is the highest ranked organization coordinating all education, research, and innovation related activities. It consists of nine member ministries or agencies.

In Korea the *Presidential Advisory Council on Science and Technology*, which is chaired by the President with 23 members, was established in June 2013. In Brazil the Ministry of Science Technology and Innovation and the Ministry of Development, Industry and Foreign Trade jointly define the industrial and technological policy priorities and in partnership with the Ministry of Finance establish the distribution of the National Fund for Scientific and Technological Development.

All countries use regularly foresight exercises in order to identify and legitimize priorities, increase collaboration and coordination and provide publicity to science, technology and innovation.

Lessons Learned identifies a number of differences between South Africa and the three comparator countries. These are as follows:

- R&D intensity (GERD/GDP, %) in South Africa (0.76% 2012/13) is substantially lower than in the other countries – China (1.84); Korea (4.36); and Brazil (1.16).
- Science and technology have been adopted by their political leadership in China and Korea as primary productive forces and sources of economic development. In South Africa science, technology and innovation are isolated in the DST.
- The **structure of the governance of S&T&I** in the comparative countries reflects their recognition of the importance of science, technology and innovation.
- When science and technology are recognised by the political authorities as critical developmental forces, the effort is to develop appropriate instruments that will achieve the policy objectives. However, when financial resources are at risk and in competition with other objectives the effort focuses in informing the decision makers for the potential benefits of science, technology and innovation. The case in the USA where universities are involved in efforts to influence their political authorities is a relevant example. The rise in federal lobbying among universities in the USA began in the 1980s in response to budget cuts in research allocation during the Reagan administration.
- Comparison of the value added of knowledge and technology intensive industries of South Africa and the comparator countries shows that South Africa has very small size of such industries. It is emphasised that these types of industries spend resources for R&D and they benefit the research sector.
- Countries recognise the different character and innovation needs of the various industries and develop appropriate relevant funding instruments. South Africa

has a limited number of funding instruments and most of them are horizontal in nature – they support many disciplines, objectives and sectors.

- Brazil has been successful in supporting R&D through levies and specific taxes (extra budgetary sectorial funds). The approach has the benefit that neutralizes the effect of other government priorities competing with investments in R&D. In South Africa the Water Research Commission is supported through water related levies.
- Foresight exercises appear to be an important instrument in focusing the political authorities on issues of priorities in science, technology and innovation. There is tentative evidence that foresight exercises affect the performance of the national system of innovation. This approach is not utilized in South Africa.

The report advances the following recommendations:

- *Universities South Africa* has the responsibility and mandate to facilitate the development of informed public policy related to Universities. ***Universities South Africa* should institutionalise advocacy activities within the organisation. Provision of evidence of the value of universities for innovation, the economy and society should be an integral part of these activities and should be disseminated to relevant stakeholders**. The organisation should also consider the monitoring of technology transfer from universities to private sector. Similarly the organisation should make sure that critical information of the sector (e.g. National R&D Expenditures) is valid before its dissemination.
- Programs based on the triple helix approach are powerful instruments bringing together Government-Industry and Universities. Such instruments are in accordance to international best practice and within the DST's efforts to promote innovation in industry on a co-funding basis. **USAf should encourage and monitor the establishment of such programmes and take appropriate actions**
- The DST's efforts to increase the number of PhDs by supporting them to study abroad provides an opportunity for the local universities. *Universities South Africa* should encourage its members to use innovative approaches that could increase PhD enrolments. The **Structured Doctoral Programmes** in Europe appear to be particularly useful for multidisciplinary and interdisciplinary areas such as nanotechnology; advanced manufacturing etc. Furthermore, PhD candidates' studies take place alternative at two different countries. **Appointing foreign professors** at the country's universities for a few months per year may be another alternative that can alleviate concerns for the lack of professors to supervise post graduates. ***Universities South Africa* could approach DFG, DAAD and the Swiss authorities to initiate relevant discussions for the establishment of such instruments. Discussions with DST could influence the Internationalization Policy.**
- **Foresight exercises** - national or sectoral - constitute integral parts of science, technology and innovation policy. Foresight activities are useful among others for planning science and technology funding; strategic decisions; defining the

strategy of an industry or sector; improving long term competitiveness; copying with changes in the socio-economic framework; attracting the attention of political authorities etc. *Universities South Africa* should consider the undertaking of foresight exercises for the university sector.

- **Support for emerging technologies** - industrial biotechnologies; synthetic biology; photonics; nanotechnology; advanced materials; advance manufacturing systems and others – is widespread internationally and the research base is critical for their development and commercialization. *Universities South Africa* should explore the issue with DST. Similarly, universities can make a contribution in participating in the Sector Specific Innovation Funds. Industry Associations that are expected to manage the process do not necessarily have research expertise and capacity and Universities can be of assistance. A number of other programs like ***The Innovation Fund for Small Technology-based Firms*** **and the SPARK Programme supporting rural development in China can be considered in South Africa as they support the national objectives.**

Using levies and small special taxes has the potential to protect R&D expenditures from budgetary variations. Universities South Africa together with the funding agencies supporting university research (i.e. NRF, WRC, MRC and SANEDI) should consider discussing the issue with DST and Treasury.
